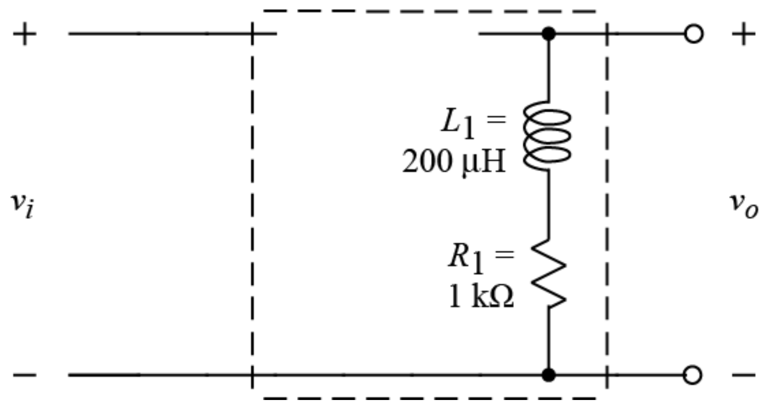
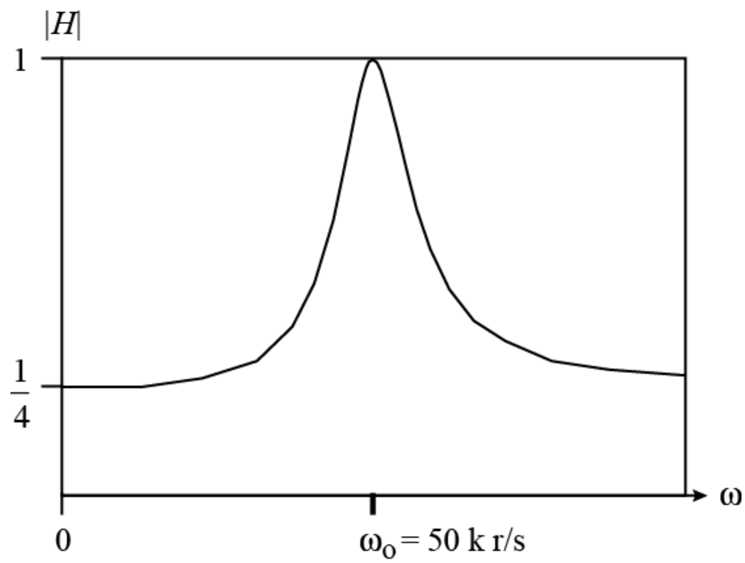
Ex:




Given the resistor and inductor connected as shown with the following values,

$R_1 = 1\text{ k}\Omega \qquad L_1 = 200\ \mu\text{H}$

and using not more than an additional one each $R$, $C$, and $L$ in the dashed-line box, design a circuit to go in the dashed-line box that will produce the **band-pass** $|H(j\omega)|$ vs. ω shown above. That is:

$$\max_{\omega}|H(j\omega)| = 1 \text{ and occurs at } \omega_0 = 50 \text{ k r/s}$$

$$|H(j\omega)| = \frac{1}{4} \text{ at } \omega = 0 \qquad \text{and} \qquad \lim_{\omega\to\infty}|H(j\omega)| = \frac{1}{4}$$

Specify values of $R$, $C$, and/or $L$, and show how they would be connected in the circuit. Note that a bandwidth is not specified, and you do not have to satisfy any more than the three requirements specified above.

**SOL'N:** If we use a series or parallel LC, our center frequency will be given by the standard formula. (Note that other configurations than a simple series or parallel LC will not necessarily obey this formula, so we need to reconsider this calculation if we choose some other configuration.)

$$\omega_o = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{200\mu \cdot C}} = 50\,\text{kr/s}$$

or

$$\omega_o^2 = \frac{1}{200\mu \cdot C} = (50\,\text{kr/s})^2$$

Rearranging, we compute the value of $C$.

$$C = \frac{1}{200\mu\text{H} \cdot \omega_o^2} = \frac{1}{200\mu(50\,\text{k})^2}\text{F} = \frac{1}{200\mu(50\,\text{k})(50\,\text{k})}\text{F}$$

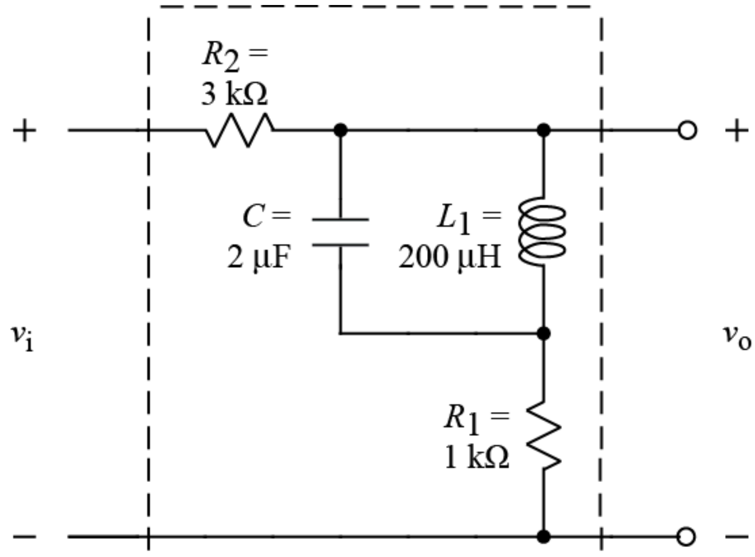
or

$$C = \frac{1}{10(50\,\text{k})}\text{F} = 2\,\mu\text{F}$$

We can obtain a peak in the transfer function by having a parallel $LC$ in the vertical segment on the right side. The $LC$ will look like an open circuit at $\omega_o$, meaning that the input will be connected to the output by a what is in the top rail with no current flow. This will give $\mathbf{V}_o = \mathbf{V}_i$ and $H(j\omega) = 1$.

At $\omega = 0$ and $\omega \rightarrow \infty$, the $L$ ro $C$ will be a short circuit, and we need some resistance in the top rail to give a voltage divider such that the output voltage is 1/4 the input voltage. Thus, we need a resistor that is three times the value of $R_1$.

We obtain the circuit shown below. As noted earlier, we should verify that we have a series or parallel $LC$. We do have a parallel $LC$, so our value for $C$ is valid.



$R_2$ =
3 kΩ
+
+
$C$ =
2 μF
$L_1$ =
200 μH
$v_i$
$v_o$
$R_1$ =
1 kΩ
−
−